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Cc: Wall, Dan[wall.dan@epa.gov]; Jan Christner
(Jan.Christner@WestonSolutions.com)[Jan.Christner@WestonSolutions.com]
From: Way, Steven
Sent: Sun 9/13/2015 1:29:31 PM
Subject: FW: GKM Technical Subcommittee- Introducing Ken Williams and Heidi Steltzer

Rob and Dan,

I thought it would be good idea if you were aware of this and possible information exchange opportunities.

We can discuss this Monday briefly.

Steve

Steven Way

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From: Kenneth Hurst Williams [mailto:khwilliams@lbl.gov]
Sent: Tuesday, September 08, 2015 10:52 PM
To: Marcie Demmy Bidwell
Cc: Peter Foster; Ann Oliver; Chris Theel; charten@southernute-nsn.gov; Fagen, Elizabeth; Patrick Pfaltzgraff; Peter Butler; Wharton, Steve; tojohns@southernute-nsn.gov; Tom McNamara; Trevor Denney; Ron.LeBlanc@durangogov.org; Hestmark, Martin; Ostrander, David; Heidi Stelzer; Way, Steven; R8EISC; Wall, Dan; Scott Roberts

Subject: Re: GKM Technical Subcommittee- Introducing Ken Williams and Heidi Steltzer

Hi everyone.

Thank you *so* much Marcie for the electronic introduction — and my *sincere* apologies in advance for the lengthy email that follows.

I also have to apologize for not being able to coordinate my recent trip to Durango-Silverton in advance. What turned out to be a combination scoping-sampling trip quickly evolved into a fairly involved sampling-oriented enterprise. That said, I was able to spend a good bit of time with Marcie, Scott Roberts, and a group of Ft. Lewis College faculty with whom Dr. Heidi Steltzer arranged a meeting. So I was at least able to get a good introduction to the various parties involved in research activities related to the spill from these Durango meetings.

As Marcie notes, I work for the Department of Energy (DOE) Lawrence Berkeley National Laboratory (LBNL) in Berkeley, CA; however, I'm currently based in Carbondale, CO where I oversee research activities related to the DOE field research stations at Rifle and Crested Butte, Colorado. The former station is the site of a former uranium mill tailings site and DOE has funded research there (and elsewhere) for the past 15+ years on metals mobility in the environment as it relates to the redox chemistry of iron and manganese oxides. Indeed, DOE's Office of Biological and Environmental Research (DOE-BER) has been a world leader in both supporting and defining the fields of radionuclide/metals geochemistry and geomicrobiology (my particular area of specialization). We've recently initiated field studies in the headwaters of the East River near Crested Butte as part of our LBNL "Sustainable Systems" Scientific Focus Area (http://esd1.lbl.gov/research/projects/sustainable_systems/) that focus on the coupling of climate, hydrology, and elemental cycling (including metals) from the scale of the genome to the watershed, with a particular focus on the terrestrial-aquatic interface. The development of reactive transport models that robustly describe and predict the interconnectedness of climate-hydrology-vegetation-biogeochemistry is a hallmark of the DOE-BER mission and one that has served as the impetus for engaging on the Animas River spill.

To this end, DOE-BER provided me with some 'rapid access' funding to initiate a sampling campaign within the Animas River drainage and to explore opportunities for collaboration with other federal and state agencies. This funding is also designed to supplement a recent National Science Foundation (NSF) RAPID access proposal investigating the spill from the perspective of a natural tracer experiment that can be used to examine the long-term behavior of metals and

metal oxide sorbents within fluvial and riparian environments. We're particularly interested in the biogeochemical trajectories that metal oxide sorbents emanating from the Gold King mine *may* follow upon burial via sediment deposition in the coming years and the implications of redox transformations that induce reductive dissolution of the oxide sorbents and/or the onset of sulfidogenesis (especially its role in mediating changes in the speciation of arsenic — a topic my group has focused on in recent years — and the precipitation of highly insoluble metal sulfides). Our work has a strong focus on linking the genomics-inspired understanding of microbial metabolic pathways with the hydrogeochemical behavior of the Animas drainage and other metals-impacted catchments like it, such as Coal Creek near Crested Butte, CO. Additionally, we're particularly interested in developing a model for cadmium (and perhaps copper and zinc) fluxes within the drainage using the stable isotope distributions on these elements within sediments and stream and pore water samples. I'm happy to provide further information on any and all topics of investigation to those who may be interested — please do not hesitate to email me with questions.

What follows is a brief description of the sampling I performed last Thursday and Friday, September 3rd and 4th:

I collected stream water samples at three locations near/in Durango (32nd St. bridge, Oxbow Park, Baker's Bridge), which included samples for water quality (T, fluid conductivity, pH, ORD, DO), DNA, metal isotopes, cations/trace metals, anions, DIC/DOC.

(1) At 32nd St. Bridge, I also collected pore water samples from 10cm and 20cm depth for the same parameters as above.

Sediments for DNA extraction and metals analysis (dry ice frozen) were collected for the 0-5cm and 5-10cm depths; sediments from 0-5cm were collected for batch incubation (refrigerated).

5-gallons of river water was collected for concentrating dissolved organic matter (DOM) to feed batch incubation experiments using sediments derived from the Animas River corridor.

N.B. As I've seen at locations along the Colorado River, sediments along the Animas River can become geochemically reduced within 1-2cm below land surface especially in the presence of organic matter. I observed what amount to Rifle, CO style "Naturally Reduced Zone (NRZ)

sediments” as a pretty common feature at the 32nd St. Bridge area, with such sulfidic conditions having implications for metal sequestration as sulfide minerals.

(2) At **Oxbow Park**, pore water samples were collected from 100cm depth (much sandier in comparison to the 32nd St. Bridge locality) to supplement the stream water samples. Sediments from 0-5cm from visibly and non-visibly reduced locations were collected for DNA, metals, and batch incubation.

(3) At **Hermosa Creek**, I collected metal isotopes, cations/trace metals, anions, DIC/DOC analysis; this location is a tributary of the Animas closer to Durango and drains an area completely distinct from the Silverton caldera. It occurs to me now that I failed to grab a DNA sample for this location but I could make arrangements to get one via collaborations with Ft. Lewis College and/or the Mountain Studies Institute.

(4) At **Baker's Bridge**, the location was upstream of the sand/gravel/boulder transition and sediments were hard to come by. Here I only collected samples for metal isotopes, cations/trace metals, anions, DIC/DOC. Some rather remarkable crusts inferred to result from the spill concentrated as mud cracks; these were collected for DNA, metals, and isotope analysis.

(5) At **A72** I collected stream water samples for water quality (T, fluid conductivity, pH, ORD, DO), DNA, metal isotopes, cations/trace metals, anions, and DIC/DOC. There were some fine grained, seemingly clay-rich materials that had collected in between the gravels (this area is very gravelly) and these solid phase materials were collected for DNA, metals, and batch incubation.

5-gallons of river water was collected for concentrating DOM.

(6) I also collected stream water samples for 7 additional locations all the way up to the Gold King mine itself for metal isotopes, cations/trace metals, anions, DIC/DOC analysis, with a primary focus on trying to isolate the distinct metal isotope signature — should it exist — for the Gold King spill/drainage (North Fork of Cement Creek).

These locations include the following:

- Mineral Creek
- Cement Creek in Silverton (location **CC48**)
- South Fork of Cement Creek
- Cement Creek above the Gold King mine and Red & Bonita mine
- Red & Bonita mine outflow/discharge
- Animas River upstream of Cement Creek

N.B. I was drawn to what appears to be a tight relationship to stream water microbial biomass (esp. algae and/or cyanobacterial mats). These features are well anchored to rock surfaces and the stream bank/bed, and I'm curious to start thinking about hypotheses that link metals-binding to such organic rich materials and their fate following burial (both metals and biomass as necrotic carbon source). Burial —> induction of sulfate-reducing conditions, immobilization of heavy metal sulfides, and potential destabilization of arsenic following formation of soluble thioarsenic species while at the same time precipitating and sequestering a host of other metal contaminants, such as Cu, Pb, Zn, and Cd. In short, those carbon/metal oxide/contaminant associations could be very important in driving long terms metals immobilization/release along the river corridor.

Best, Ken

Kenneth H. Williams, PhD

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